

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC 20460

OFFICE OF CHEMICAL SAFETY AND POLLUTION PREVENTION



July 19, 2013

MEMORANDUM:

Subject: Occupational Exposure Assessment for the Proposed Label Amendment to Reduce the REI for Synergize Fogging Applications to Hatcheries.

PC Code: 043901, 069175	DP Barcode: D412813
Decision No.: 479830	Registration No.: 66171-7
Petition No.: NA	Regulatory Action: (A572) New Product or Amendment Requiring Data Review for Risk Assessment
Risk Assess Type: Single Chemical	Case No.: NA
TXR No.: NA	CAS No.: 111-30-8, 68391-01-5
MRID No.: 49153101	40 CFR: NA

From: Timothy C. Dole, CIH, Industrial Hygienist
Risk Assessment and Science Support Branch (RASSB)
Antimicrobials Division (7510P)

A handwritten signature in black ink, reading "Timothy C. Dole", is positioned to the right of the "From:" line.

Thru: Timothy Leighton, Senior Scientist
Risk Assessment and Science Support Branch (RASSB)
Antimicrobials Division (7510P)

A handwritten signature in black ink, reading "Timothy Leighton", is positioned to the right of the "Thru:" line.

And

Steve Weiss, Branch Chief
Risk Assessment and Science Support Branch (RASSB)
Antimicrobials Division (7510P)

A handwritten signature in black ink, reading "Steve Weiss", is positioned to the right of the "And" line.

To: Velma Noble, Chemical Review Manager
Regulatory Management Branch II
Antimicrobials Division (7510P)

Attached is the Occupational Exposure Assessment in support of the proposed label amendment to reduce the re-entry interval (REI) for Synergize fogging applications to hatcheries.

1.0 Introduction and Background

Synergize Cleaner-Disinfectant (EPA Reg. No. 66171-7) registered by Preserve International, contains 26.0 percent alkyl dimethyl benzyl ammonium chloride (ADBAC) and 7.0 percent glutaraldehyde (GA) as the active ingredients (a.i.). Preserve International has submitted a proposed label amendment to reduce the Re-entry Interval (REI) for Hatchery Rooms to 10 to 25 minutes. The exact REI, which depends on the ventilation rate expressed as Air Exchanges per Hour (which is the same as Air Changes per Hour) and the fogging time, is listed in a table on page two of the label under the heading: A) Hatchery Rooms. This amendment also includes a rate clarification and reduction whereby 1 part Synergize is added to 42 parts water and fogged into the room at a rate of 3.8 ounces per minute per 10,000 cubic feet. The fogging times are based on the ACH and range from 5 minutes for 8 ACH to 15 minutes for 24 ACH. The fogging is typically accomplished using a fixed system that includes a certain number of nozzles per unit volume to provide good dispersion into the area being treated. The label indicates that the fogging must be done with the ventilation system in operation.

The existing label has an REI of 2 hours for hatchery applications where the application rate is 1 part Synergize to two parts water. This REI was based on the ADBAC Occupational and Residential Exposure (ORE) Assessment (US EPA, 2006a) that was written for the ADBAC RED (US EPA 2006b). The ADBAC ORE assessment calculated an initial concentration of 381 mg/m³ based on the application of a different product containing 21.7% ADBAC at the rate of 0.42 gallons per 4000 ft³ to a poultry barn. The poultry barn was assumed to have an ACH of 4 which yielded an 8 hour average air concentration of 44.6 mg/m³ with no REI and 0.01496 mg/m³ with a 2 hour REI. These air concentrations yielded MOEs of 0.5 and 1,500 when compared against the NOAEL of 3 mg/kg/day that was used to evaluate ADBAC inhalation exposures. Because the NOAEL was from an oral study, the target MOE was 1,000 and thus the 2 hour REI was required by the RED to achieve an exposure that did not generate risks of concern.

The existing product also contains 7% glutaraldehyde (GA) and calculations that were performed for the GA ORE Assessment (US EPA, 2007a) that was written for the GA RED (US EPA, 2007b) indicated that an REI of 3 hours would be required. The initial concentration of 101 mg/m³ (25,000 ppb) was calculated based on the application of 1 part product containing 10.725% GA in four parts water at the rate of 125 ounces 1000 yd³ to a poultry barn. The poultry barn was also assumed to have an ACH of 4. The initial concentration declined to 47 ppb in 94 minutes and 0.30 ppb in 170 minutes. These air concentrations were compared to the ACGIH TLV of 50 ppb, which is relevant for peak exposures, and the EPA short term RfC of 0.32 ppb, which is relevant for 8 hour time weighted average exposures, and based on these comparisons, the REI of 180 minutes (i.e. 3 hours) was included in the RED. The REI was intended to ensure that peak exposures did not exceed the TLV and that 8 hour TWA exposures did not exceed the RfC.

The calculations for ADBAC and GA presented in the RED were based on the poultry house use because it was assumed that it represented worse case conditions since the poultry house is empty and ventilation system is turned off during the application. Preserve International has since indicated these conditions are not representative of hatchery rooms, which are treated while

occupied with eggs, and with the ventilation system in operation. Given this information and the use directions included on the proposed label, the air concentrations during and after fogging applications to a hatchery were calculated and compared to the toxicology endpoints listed in Section 2 of this document.

2.0 Toxicology Endpoints

2.1 ADBAC

The toxicology endpoints that were used for assessing risk to ADBAC in this memo are the same as those used in the ADBAC ORE Assessment for the RED (US EPA, 2006a) and are included in Table 1. Subsequent to the RED, the OPP guidance is to include the previous 10X uncertainty factor (UF) used for route to route extrapolation as a 10X database uncertainty factor (DBUF) and the target MOE is now 1000.

Table 1 ADBAC Toxicological Endpoints for Inhalation Risk Assessment			
Exposure Scenario	Dose Used in Risk Assessment (mg/kg/day)	Target Margin of Exposure (MOE) or Uncertainty Factor (UF)	Study and Toxicological Effects
Inhalation (Any time point)	NOAEL= 3 mg/kg/day MOE = 100 ^A	UF = 100 (10x inter-species extrapolation, 10x intra-species variation)	Developmental Toxicity – rabbit, MRID 42392801 LOAEL = 9 mg/kg/day, based on clinical signs of toxicity in maternal rabbits
A. An additional 10x is used for route extrapolation to determine if a confirmatory study is needed NOAEL = no observed adverse effect level, LOAEL = lowest observed adverse effect level			

2.2 Glutaraldehyde

The toxicological endpoints for GA that were used for this assessment are summarized in Table 2 and they are also the same endpoints that were used in the GA ORE Assessment for the RED (US EPA, 2007a).

Table 2 – Glutaraldehyde Toxicological Endpoints for Inhalation Risk Assessment			
Exposure Scenario	Dose Used in Risk Assessment	UF	Study and Toxicological Effects
Inhalation Exposures			
Short Term Occupational (8 hours/day)	NOAEL = 0.7 mg/m ³ HEC _{occ} = 0.041 mg/m ³ 'RfC _{occ} ' = 0.0013 mg/m ³ (0.32 ppb*)	30	Two-week inhalation toxicity study in rats and mice (NIH pub 93-3348). LOAEL = 2.0 mg/m ³ based upon histo-pathological alterations of the nasal passages, larynx, trachea and lung.
Intermediate Term Occupational (8 hours/day)	NOAEL = 0.51 mg/m ³ HEC _{occ} = 0.03 mg/m ³ 'RfC _{occ} ' = 0.001 mg/m ³ (0.24 ppb*)	30	Thirteen week inhalation toxicity study in rats and mice (NIH pub 93-3348). LOAEL = 1.02 mg/m ³ based upon histo-pathological changes of the nasal and respiratory tract epithelium.

Table 2 – Glutaraldehyde Toxicological Endpoints for Inhalation Risk Assessment			
Exposure Scenario	Dose Used in Risk Assessment	UF	Study and Toxicological Effects
Long Term Occupational (8 hours/day)	LOAEL = 0.26 mg/m ³ HEC _{occ} = 0.019 mg/m ³ 'RfC _{occ} ' = 0.00006 mg/m ³ (0.015 ppb*)	300	Two -Year inhalation toxicity study in rats and mice (MRID 448422-02). LOAEL = 0.26 mg/m ³ based upon squamous epithelial hyperplasia/inflammation and turbinate necrosis.
* Unit Conversion: ppb = (mg/m ³ x 24.45 x 1000 ug/mg) / mw. For glutaraldehyde: 1 ppb = 0.00409 mg/m ³			

Non-EPA Occupational Exposure Limits for Glutaraldehyde

The American Conference of Governmental Hygienists (ACGIH) has evaluated the GA literature and recommended a threshold limit value (TLV) as a ceiling (C) value. A TLV-Ceiling is a threshold limit value that should not be exceeded at any time during the workday and is normally assessed as a 15 minute exposure. Although the ACGIH did review the same animal toxicity studies that were used by EPA, the ACGIH chose a ceiling value because the literature indicated that short term exposures at or below 100 ppb resulted in symptoms of nose, throat, skin and eye irritation among medical workers using GA. The TLV-Ceiling for GA was not based on the same methodology that EPA uses to establish RfCs.

The Occupational Health and Safety Administration (OSHA) has not established a Permissible Exposure Limit (PEL) for GA.

3.0 GA and ADBAC Air Concentration Calculations Based on the Proposed Label

The GA and ADBAC air concentrations were calculated based on the instructions included in the proposed label. These calculations were done for both the increase that occurs during application and the decrease that follows application.

3.1 Increasing Air Concentrations during Application

To account for the increasing air concentrations during application, a simplified version of the time dependent Well Mixed Box model from Mathematical Models for Estimating Occupational Exposure to Chemicals (AIHA, 2000) was used. This formula is as follows:

$$C_T = G_R/Q * \{1 - e^{[Q*(T-T_0)]/V}\}$$

Where:

C_T = Air concentration at time T

G_R = Generation rate (mass/time)

Q = Ventilation rate in cubic feet per minute (CFM)

T = End time in minutes

T₀ = Beginning time in minutes

V = Volume of room in cubic feet

3.2 Decreasing Air Concentrations after Application

The decreasing air concentrations after application were calculated using the following single chamber ventilation formula that is included in the EPA Multi- Chamber Concentration and Exposure Model (MCCEM):

$$C_T = C_0 * 0.5 [(T/0.693) * (Q/V)]$$

Where:

C_T = Air concentration at time T

C_0 = Air Concentration at time zero

Q = Ventilation rate in cubic feet per minute (CFM)

T = Elapsed time in minutes

V = Volume of room in cubic feet

3.3 Assumptions

The following assumptions were used in the above formulas:

- The generation rate (G_R) for glutaraldehyde (GA) was assumed to be 183.2 mg per minute based on the GA content of the product (7.0 percent), a dilution of 1 part product to 42 parts water and an application rate of 3.8 liquid ounces per minute.
- The generation rate (G_R) for ADBAC was assumed to be 680 mg per minute based on the ADBAC content of the product (26.0 percent), a dilution of 1 part product to 42 parts water and an application rate of 3.8 liquid ounces per minute.
- The room volume was assumed to be 10,000 cubic feet based on the label application rate of 3.8 liquid ounces per minute per 10,000 cubic feet.
- The ventilation rate was assumed to be 8, 12, 16, 20 and 24 air changes (or exchanges) per hour based on the label.
- The application (i.e. fogging) times were assumed to be 5, 7.5, 10, 12.5 and 15 minutes, corresponding to the above listed ventilation rates, based on the label.
- The ADBAC daily dose is calculated using a breathing rate is 1.25 M³ per hour and a body weight of 69 kg, which the average weight for adult females (US EPA, 2011). This body weight was used because the endpoint is based on maternal effects observed during a developmental toxicity study.
- It is assumed that the application is made once per day based on the instructions given for Incubators and Hatchers.

4.0 Risk Summary for Inhalation Exposure to ADBAC and GA

4.1 Glutaraldehyde (GA)

The estimated air concentrations for GA are summarized in Table 3 and the calculations are included in Appendix A. These air concentrations indicate GA inhalation exposures will not exceed either the ACGIH TLV of 50 ppb for peak exposures upon re-entry into the hatchery, or the EPA RfC of 0.32 ppb as an eight hour time weighted average (8 hr TWA). This means that the risks from inhalation exposure to GA are not of concern.

Hatchery Room Ventilation Rate (ACH)	Fogging Time (Minutes)	GA in Air at End of Fogging (ppb)	Re-Entry Interval (Minutes)	GA in Air after REI (ppb)	Exceeds TLV of 50 ppb?	GA 8 Hour TWA Starting after the REI (ppb)	Exceeds EPA RfC of 0.32 ppb?
8	5	578	25	21 ppb	No	0.30	No
12	7.5	615	15	25	No	0.29	No
16	10	552	10	29	No	0.26	No
20	12.5	467	10	12	No	0.088	No
24	15	395	10	4.8	No	0.031	No

ACH = Air Changes per Hour

4.1 ADBAC

The estimated air concentrations for ADBAC are summarized in Table 4 and the calculations are included in Appendix B. The MOEs based on these air concentrations range from 4,500 to 45,000 and they are greater than the target MOE of 1,000. This means that the risks from inhalation exposure to ADBAC are not of concern.

Hatchery Room Ventilation Rate	Fogging Time (Minutes)	ADBAC in Air at End of Fogging (mg/M ³)	Re-Entry Interval (Minutes)	ADBAC in Air after REI (mg/M ³)	ADBAC 8 hr TWA ^B (mg/M ³)	ADBAC Daily Dose ^C (mg/kg/day)	ADBAC MOE ^D
8 ACH ^A	5	8.8	25	0.27	0.0046	0.00066	4,500
12 ACH	7.5	9.3	15	0.38	0.0044	0.00064	4,700
16 ACH	10	8.4	10	0.45	0.0040	0.00058	5,200
20 ACH	12.5	7.2	10	0.18	0.0013	0.00019	16,000
24 ACH	15	6.0	10	0.074	0.00046	0.000067	45,000

A. ACH = Air Changes per Hour

B. 8 hr TWA = Average ADBAC Air concentration for the eight hour period starting after the REI.

C. Daily Dose = [8 hr TWA (mg/m³) * Breathing Rate (1.25 m³/hr) * Exposure Time (8 hr/day)] / [BW (69 kg)]

D. MOE = NOAEL (3 mg/kg/day) / Daily Dose (mg/kg/day)

5.0 Conclusions and Recommendations

The above calculations indicate that proposed label amendments (as indicated on the label of 7/18/2013) to reduce the application rate and the reentry intervals (REIs) will not result in risks of concern for either ADBAC or glutaraldehyde. RASSB recommends that this label be approved as submitted.

References

AIHA, 2000. Mathematical Models for Estimating Occupational Exposure to Chemicals, AIHA Exposure Assessment Strategies Committee, Modeling Subcommittee, American Industrial Hygiene Association, 2000

US EPA, 2006a. Alkyl Dimethyl Benzyl Ammonium Chloride (ADBAC) Occupational and Residential Exposure Assessment for the Antimicrobial Uses, August 1, 2006 (Available on Regulations.Gov under Docket ID EPA-OPP-2006-0339)

US EPA, 2006b. Registration Eligibility Decision for Alkyl Dimethyl Benzyl Ammonium Chloride (ADBAC), August, 2006

US EPA, 2007a. Glutaraldehyde: 2nd Revised Occupational and Residential Exposure Assessment for the Registration Eligibility Decision. D327476, September 28, 2007

US EPA, 2007b. Registration Eligibility Decision for Glutaraldehyde, September 2007.

US EPA, 2011. Exposure Factors Handbook 2011 Edition (Final). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-09/052F, 2011.

Appendix A - Glutaraldehyde Air Concentrations for Hatchery Fogging

Spreadsheet 1 - 24 Air Changes per Hour

Application Parameters

Amount Ai in Product	7 percent
Dilution Rate (1 in X)	42
Product Concentration in Diluted Solution	2.33 percent
Application Rate of Dilute Solution	3.8 liquid oz/minute
Application Rate of Product	0.0884 liquid oz/minute
Amount Ai Applied (Assuming 128 liquid oz/ gallon and 8.35 lb/ gallon)	0.000404 lb
Amount Ai Applied (Assuming 454 gm/lb and 1000 mg per gm)	183.2 mg
Volume Treated	10000 ft3
Air Changes per Hour	24
Room Volume (Assuming 28.3 liters/ft3 and 1000 liters/m3)	283 m3
Ventilation Rate	113.2 m3/min

Rate of Increase Formula

$$C = (GA/Q) * (1 - e^{-QT/V})$$

Rate of Decrease Formula

$$C = C@ \text{ Time Zero} * 0.5^{(T/0.693 * Q/V)}$$

Where:

Glutaraldehyde air concentration (C)	mg/m3
Generation Rate (GA)	183.2 mg/min
Ventilation Rate (Q)	113.2 M3/min
Room Volume (V)	283 M3
Elapsed Time (T)	Minutes

Re-Entry Interval (REI) 10 Minutes

Increase During Application

Time	GA/Q	QT/V	e ^{-QT/V}	C (mg/m3)	C (ppb)
0	1.618	0.00	1.000	0.00	0.00
1	1.618	0.40	0.670	0.53	130
2	1.618	0.80	0.449	0.89	218
3	1.618	1.20	0.301	1.13	277
4	1.618	1.60	0.202	1.29	316
5	1.618	2.00	0.135	1.40	342
6	1.618	2.40	0.091	1.47	360
7	1.618	2.80	0.061	1.52	372
8	1.618	3.20	0.041	1.55	380
9	1.618	3.60	0.027	1.57	385
10	1.618	4.00	0.018	1.59	388
11	1.618	4.40	0.012	1.60	391
12	1.618	4.80	0.008	1.61	392
13	1.618	5.20	0.006	1.61	394
14	1.618	5.60	0.004	1.61	394
15	1.618	6.00	0.002	1.61	395

Decline following Application

Time (Min)	C (ppb)	8 Hr TWA with REI (ppb)
0	395	
1	265	
2	177	
3	119	
4	80	
5	53	
6	36	
7	24	
8	16	
9	11	
10	7.2	
11	4.8	0.031
12	3.2	
13	2.2	
14	1.5	
15	1.0	

Appendix A - Glutaraldehyde Air Concentrations for Hatchery Fogging

Spreadsheet 2 - 20 Air Changes per Hour

Application Parameters

Amount Ai in Product	7 percent
Dilution Rate (1 in X)	42
Product Concentration in Diluted Solution	2.33 percent
Application Rate of Dilute Solution	3.8 liquid oz/minute
Application Rate of Product	0.0884 liquid oz/minute
Amount Ai Applied (Assuming 128 liquid oz/ gallon and 8.35 lb/ gallon)	0.000404 lb
Amount Ai Applied (Assuming 454 gm/lb and 1000 mg per gm)	183.2 mg
Volume Treated	10000 ft3
Air Changes per Hour	20
Room Volume (Assuming 28.3 liters/ft3 and 1000 liters/m3)	283 m3
Ventilation Rate	94.3 m3/min

Rate of Increase Formula

$$C = (GA/Q) * (1 - e^{-QT/V})$$

Where:

Glutaraldehyde air concentration (C)	mg/m3
Generation Rate (GA)	183.2 mg/min
Ventilation Rate (Q)	94.3 M3/min
Room Volume (V)	283 M3
Elapsed Time (T)	Minutes

Rate of Decrease Formula

$$C = C@ \text{ Time Zero} * 0.5^{(T/0.693 * Q/V)}$$

Re-Entry Interval (REI) 10 Minutes

Increase During Application

Time	GA/Q	QT/V	e ^{-QT/V}	C (mg/m3)	C (ppb)
0	1.942	0.00	1.000	0.00	0.00
1	1.942	0.33	0.717	0.55	135
2	1.942	0.67	0.513	0.94	231
3	1.942	1.00	0.368	1.23	300
4	1.942	1.33	0.264	1.43	350
5	1.942	1.67	0.189	1.58	385
6	1.942	2.00	0.135	1.68	411
7	1.942	2.33	0.097	1.75	429
8	1.942	2.67	0.070	1.81	442
9	1.942	3.00	0.050	1.85	451
10	1.942	3.33	0.036	1.87	458
11	1.942	3.67	0.026	1.89	463
12	1.942	4.00	0.018	1.91	466
12.5	1.942	4.17	0.016	1.91	467

Decline following Application

Time (Min)	C (ppb)	8 Hr TWA with REI (ppb)
0	467	
1	335	
2	240	
3	172	
4	123	
5	88	
6	63	
7	45	
8	32	
9	23	
10	17	
11	12	0.088
12	9	
13	6	

Appendix A - Glutaraldehyde Air Concentrations for Hatchery Fogging

Spreadsheet 3 - 16 Air Changes per Hour

Application Parameters

Amount Ai in Product	7 percent
Dilution Rate (1 in X)	42
Product Concentration in Diluted Solution	2.33 percent
Application Rate of Dilute Solution	3.8 liquid oz/minute
Application Rate of Product	0.0884 liquid oz/minute
Amount Ai Applied (Assuming 128 liquid oz/ gallon and 8.35 lb/ gallon)	0.000404 lb
Amount Ai Applied (Assuming 454 gm/lb and 1000 mg per gm)	183.2 mg
Volume Treated	10000 ft3
Air Changes per Hour	16
Room Volume (Assuming 28.3 liters/ft3 and 1000 liters/m3)	283 m3
Ventilation Rate	75.5 m3/min

Rate of Increase Formula

$$C = (GA/Q) * (1 - e^{-Qt/V})$$

Where:

Glutaraldehyde air concentration (C)	mg/m3
Generation Rate (GA)	183.2 mg/min
Ventilation Rate (Q)	75.5 M3/min
Room Volume (V)	283 M3
Elapsed Time (T)	Minutes

Rate of Decrease Formula

$$C = C@ \text{ Time Zero} * 0.5^{(T/0.693 * Q/V)}$$

Re-Entry Interval (REI) 10 Minutes

Increase During Application

Time	GA/Q	QT/V	e ^{-QT/V}	C (mg/m3)	C (ppb)
0	2.428	0.00	1.000	0.00	0.00
1	2.428	0.27	0.766	0.57	139
2	2.428	0.53	0.587	1.00	245
3	2.428	0.80	0.449	1.34	327
4	2.428	1.07	0.344	1.59	389
5	2.428	1.33	0.264	1.79	437
6	2.428	1.60	0.202	1.94	474
7	2.428	1.87	0.155	2.05	502
8	2.428	2.13	0.118	2.14	523
9	2.428	2.40	0.091	2.21	540
10	2.428	2.67	0.070	2.26	552

Decline following Application

Time (Min)	C (ppb)	8 Hr TWA with REI (ppb)
0	552	
1	423	
2	324	
3	248	
4	190	
5	146	
6	111	
7	85	
8	65	
9	50	
10	38	
11	29	0.261

Appendix A - Glutaraldehyde Air Concentrations for Hatchery Fogging

Spreadsheet 4 - 12 Air Changes per Hour

Application Parameters

Amount Ai in Product	7 percent
Dilution Rate (1 in X)	42
Product Concentration in Diluted Solution	2.33 percent
Application Rate of Dilute Solution	3.8 liquid oz/minute
Application Rate of Product	0.0884 liquid oz/minute
Amount Ai Applied (Assuming 128 liquid oz/ gallon and 8.35 lb/ gallon)	0.000404 lb
Amount Ai Applied (Assuming 454 gm/lb and 1000 mg per gm)	183.2 mg
Volume Treated	10000 ft3
Air Changes per Hour	12
Room Volume (Assuming 28.3 liters/ft3 and 1000 liters/m3)	283 m3
Ventilation Rate	56.6 m3/min

Rate of Increase Formula

$$C = (GA/Q) * (1 - e^{-Qt/V})$$

Rate of Decrease Formula

$$C = C@ \text{ Time Zero} * 0.5^{(T/0.693 * Q/V)}$$

Where:

Glutaraldehyde air concentration (C)	mg/m3
Generation Rate (GA)	183.2 mg/min
Ventilation Rate (Q)	56.6 M3/min
Room Volume (V)	283 M3
Elapsed Time (T)	Minutes

Re-Entry Interval (REI) 15 Minutes

Increase During Application

Time	GA/Q	QT/V	e ^{-QT/V}	C (mg/m3)	C (ppb)
0	3.237	0.00	1.000	0	0
1	3.237	0.20	0.819	0.59	143
2	3.237	0.40	0.670	1.07	261
3	3.237	0.60	0.549	1.46	357
4	3.237	0.80	0.449	1.78	436
5	3.237	1.00	0.368	2.05	500
6	3.237	1.20	0.301	2.26	553
7	3.237	1.40	0.247	2.44	596
7.5	3.237	1.50	0.223	2.51	615

Decline following Application

Time (Min)	C (ppb)	8 Hr TWA with REI (ppb)
0	615	
1	503	
2	412	
3	337	
4	276	
5	226	
6	185	
7	152	
8	124	
9	102	
10	83	
11	68	
12	56	
13	46	
14	37	
15	31	
16	25	0.287

Appendix A - Glutaraldehyde Air Concentrations for Hatchery Fogging

Spreadsheet 5 - 8 Air Changes per Hour

Application Parameters

Amount Ai in Product	7 percent
Dilution Rate (1 in X)	42
Product Concentration in Diluted Solution	2.33 percent
Application Rate of Dilute Solution	3.8 liquid oz/minute
Application Rate of Product	0.0884 liquid oz/minute
Amount Ai Applied (Assuming 128 liquid oz/ gallon and 8.35 lb/ gallon)	0.000404 lb
Amount Ai Applied (Assuming 454 gm/lb and 1000 mg per gm)	183.2 mg
Volume Treated	10000 ft3
Air Changes per Hour	8
Room Volume (Assuming 28.3 liters/ft3 and 1000 liters/m3)	283 m3
Ventilation Rate	37.7 m3/min

Rate of Increase Formula

$$C = (GA/Q) * (1 - e^{-Qt/V})$$

Where:

Glutaraldehyde air concentration (C)	mg/m3
Generation Rate (GA)	183.2 mg/min
Ventilation Rate (Q)	37.7 M3/min
Room Volume (V)	283 M3
Elapsed Time (T)	Minutes

Rate of Decrease Formula

$$C = C@ \text{ Time Zero} * 0.5^{(T/0.693 * Q/V)}$$

Re-Entry Interval (REI) 25 Minutes

Increase During Application

Time	GA/Q	QT/V	$e^{-QT/V}$	C (mg/m3)	C (ppb)
0	4.855	0.00	1.000	0	0
1	4.855	0.13	0.875	0.61	148
2	4.855	0.27	0.766	1.14	278
3	4.855	0.40	0.670	1.60	391
4	4.855	0.53	0.587	2.01	491
5	4.855	0.67	0.513	2.36	578

Decline following Application

Time (Min)	C (ppb)	8 Hr TWA with REI (ppb)
0	578	
1	505	
2	442	
3	387	
4	339	
5	297	
6	259	
7	227	
8	199	
9	174	
10	152	
11	133	
12	117	
13	102	
14	89	
15	78	
16	68	
17	60	
18	52	
19	46	
20	40	
21	35	
22	31	
23	27	
24	24	
25	21	
26	18	0.300

Appendix B - ADBAC Air Concentrations for Hatchery Fogging

Spreadsheet 1 - 24 Air Changes per Hour

Application Parameters

Amount Ai in Product	26 percent
Dilution Rate (1 in X)	42
Product Concentration in Diluted Solution	2.33 percent
Application Rate of Dilute Solution	3.8 liquid oz/minute
Application Rate of Product	0.0884 liquid oz/minute
Amount Ai Applied (Assuming 128 liquid oz/ gallon and 8.35 lb/ gallon)	0.00150 lb
Amount Ai Applied (Assuming 454 gm/lb and 1000 mg per gm)	680.5 mg
Volume Treated	10000 ft ³
Air Changes per Hour	24
Room Volume (Assuming 28.3 liters/ft ³ and 1000 liters/m ³)	283 m ³
Ventilation Rate	113.2 m ³ /hr

Rate of Increase Formula

$$C = (GA/Q) * (1 - e^{-Qt/V})$$

Where:

ADBAC air concentration (C)	mg/m ³
Generation Rate (GA)	680.5 mg/min
Ventilation Rate (Q)	113.2 M ³ /min
Room Volume (V)	283 M ³
Elapsed Time (T)	Minutes

Rate of Decrease Formula

$$C = C@ \text{ Time Zero} * 0.5^{(T/0.693 * Q/V)}$$

Re-entry Interval (REI) = 10 Minutes

Increase During Application

Time	GA/Q	QT/V	e ^{-QT/V}	C (mg/m ³)
0	6.011	0.00	1.000	0.00
1	6.011	0.40	0.670	1.98
2	6.011	0.80	0.449	3.31
3	6.011	1.20	0.301	4.20
4	6.011	1.60	0.202	4.80
5	6.011	2.00	0.135	5.20
6	6.011	2.40	0.091	5.47
7	6.011	2.80	0.061	5.65
8	6.011	3.20	0.041	5.77
9	6.011	3.60	0.027	5.85
10	6.011	4.00	0.018	5.90
11	6.011	4.40	0.012	5.94
12	6.011	4.80	0.008	5.96
13	6.011	5.20	0.006	5.98
14	6.011	5.60	0.004	5.99
15	6.011	6.00	0.002	6.00

Decline following Application

Time (Min)	C (mg/m ³)	8 Hr TWA with REI (mg/m ³)
0	6.0	
1	4.0	
2	2.7	
3	1.8	
4	1.2	
5	0.81	
6	0.54	
7	0.36	
8	0.24	
9	0.16	
10	0.11	
11	0.074	0.00046
12	0.049	
13	0.033	
14	0.022	
15	0.015	

Appendix B - ADBAC Air Concentrations for Hatchery Fogging Spreadsheet 2 - 20 Air Changes per Hour

Application Parameters

Amount Ai in Product	26 percent
Dilution Rate (1 in X)	42
Product Concentration in Diluted Solution	2.33 percent
Application Rate of Dilute Solution	3.8 liquid oz/minute
Application Rate of Product	0.0884 liquid oz/minute
Amount Ai Applied (Assuming 128 liquid oz/ gallon and 8.35 lb/ gallon)	0.00150 lb
Amount Ai Applied (Assuming 454 gm/lb and 1000 mg per gm)	680.5 mg
Volume Treated	10000 ft3
Air Changes per Hour	20
Room Volume (Assuming 28.3 liters/ft3 and 1000 liters/m3)	283 m3
Ventilation Rate	94.3 m3/hr

Rate of Increase Formula

$$C = (GA/Q) * (1 - e^{-QT/V})$$

Where:

ADBAC air concentration (C)	mg/m3
Generation Rate (GA)	680.5 mg/min
Ventilation Rate (Q)	94.3 M3/min
Room Volume (V)	283 M3
Elapsed Time (T)	Minutes

Rate of Decrease Formula

$$C = C@ \text{ Time Zero} * 0.5^{(T/0.693 * Q/V)}$$

Re-entry Interval (REI) = 10 Minutes

Increase During Application

Time	GA/Q	QT/V	$e^{-QT/V}$	C (mg/m3)
0	7.214	0.00	1.000	0.00
1	7.214	0.33	0.717	2.04
2	7.214	0.67	0.513	3.51
3	7.214	1.00	0.368	4.56
4	7.214	1.33	0.264	5.31
5	7.214	1.67	0.189	5.85
6	7.214	2.00	0.135	6.24
7	7.214	2.33	0.097	6.51
8	7.214	2.67	0.070	6.71
9	7.214	3.00	0.050	6.85
10	7.214	3.33	0.036	6.96
11	7.214	3.67	0.026	7.03
12	7.214	4.00	0.018	7.08
12.5	7.214	4.17	0.016	7.10

Decline following Application

Time (Min)	C (mg/m3)	8 Hr TWA with REI (mg/m3)
0	7.1	
1	5.1	
2	3.6	
3	2.6	
4	1.9	
5	1.3	
6	1.0	
7	0.69	
8	0.49	
9	0.35	
10	0.25	
11	0.18	0.0013
12	0.13	
13	0.09	

Appendix B - ADBAC Air Concentrations for Hatchery Fogging Spreadsheet 3 -16 Air Changes per Hour

Application Parameters

Amount Ai in Product	26 percent
Dilution Rate (1 in X)	42
Product Concentration in Diluted Solution	2.33 percent
Application Rate of Dilute Solution	3.8 liquid oz/minute
Application Rate of Product	0.0884 liquid oz/minute
Amount Ai Applied (Assuming 128 liquid oz/ gallon and 8.35 lb/ gallon)	0.00150 lb
Amount Ai Applied (Assuming 454 gm/lb and 1000 mg per gm)	680.5 mg
Volume Treated	10000 ft3
Air Changes per Hour	16
Room Volume (Assuming 28.3 liters/ft3 and 1000 liters/m3)	283 m3
Ventilation Rate	75.5 m3/hr

Rate of Increase Formula

$$C = (GA/Q) * (1 - e^{-Qt/V})$$

Where:

ADBAC air concentration (C)	mg/m3
Generation Rate (GA)	680.5 mg/min
Ventilation Rate (Q)	75.5 M3/min
Room Volume (V)	283 M3
Elapsed Time (T)	Minutes

Rate of Decrease Formula

$$C = C@ \text{ Time Zero} * 0.5^{(T/0.693 * Q/V)}$$

Re-entry Interval (REI) = 10 Minutes

Increase During Application

Time	GA/Q	QT/V	$e^{-QT/V}$	C (mg/m3)
0	9.017	0.00	1.000	0.0
1	9.017	0.27	0.766	2.1
2	9.017	0.53	0.587	3.7
3	9.017	0.80	0.449	5.0
4	9.017	1.07	0.344	5.9
5	9.017	1.33	0.264	6.6
6	9.017	1.60	0.202	7.2
7	9.017	1.87	0.155	7.6
8	9.017	2.13	0.118	7.9
9	9.017	2.40	0.091	8.2
10	9.017	2.67	0.070	8.4

Decline following Application

Time (Min)	C (mg/m3)	8 Hr TWA with REI (mg/m3)
0	8.4	
1	6.4	
2	4.9	
3	3.8	
4	2.9	
5	2.2	
6	1.7	
7	1.3	
8	1.0	
9	0.76	
10	0.58	
11	0.45	0.0040

Appendix B - ADBAC Air Concentrations for Hatchery Fogging Spreadsheet 4 -12 Air Changes per Hour

Application Parameters

Amount Ai in Product	26 percent
Dilution Rate (1 in X)	42
Product Concentration in Diluted Solution	2.33 percent
Application Rate of Dilute Solution	3.8 liquid oz/minute
Application Rate of Product	0.0884 liquid oz/minute
Amount Ai Applied (Assuming 128 liquid oz/ gallon and 8.35 lb/ gallon)	0.00150 lb
Amount Ai Applied (Assuming 454 gm/lb and 1000 mg per gm)	680.5 mg
Volume Treated	10000 ft3
Air Changes per Hour	12
Room Volume (Assuming 28.3 liters/ft3 and 1000 liters/m3)	283 m3
Ventilation Rate	56.6 m3/hr

Rate of Increase Formula

$$C = (GA/Q) * (1 - e^{-Qt/V})$$

Where:

ADBAC air concentration (C)	mg/m3
Generation Rate (GA)	680.5 mg/min
Ventilation Rate (Q)	56.6 M3/min
Room Volume (V)	283 M3
Elapsed Time (T)	Minutes

Increase During Application

Time	GA/Q	QT/V	$e^{-QT/V}$	C (mg/m3)
0	12.023	0.00	1.000	0
1	12.023	0.20	0.819	2.2
2	12.023	0.40	0.670	4.0
3	12.023	0.60	0.549	5.4
4	12.023	0.80	0.449	6.6
5	12.023	1.00	0.368	7.6
6	12.023	1.20	0.301	8.4
7	12.023	1.40	0.247	9.1
7.5	12.023	1.50	0.223	9.3

Rate of Decrease Formula

$$C = C@ \text{ Time Zero} * 0.5^{(T/0.693 * Q/V)}$$

Re-entry Interval (REI) = 15 Minutes

Decline following Application

Time (Min)	C (mg/m3)	8 Hr TWA with REI (mg/m3)
0	9.3	
1	7.6	
2	6.3	
3	5.1	
4	4.2	
5	3.4	
6	2.8	
7	2.3	
8	1.9	
9	1.5	
10	1.3	
11	1.0	
12	0.85	
13	0.69	
14	0.57	
15	0.46	
16	0.38	0.0044

Appendix B - ADBAC Air Concentrations for Hatchery Fogging

Spreadsheet 5 - 8 Air Changes per Hour

Application Parameters

Amount Ai in Product	26 percent
Dilution Rate (1 in X)	42
Product Concentration in Diluted Solution	2.33 percent
Application Rate of Dilute Solution	3.8 liquid oz/minute
Application Rate of Product	0.0884 liquid oz/minute
Amount Ai Applied (Assuming 128 liquid oz/ gallon and 8.35 lb/ gallon)	0.00150 lb
Amount Ai Applied (Assuming 454 gm/lb and 1000 mg per gm)	680.5 mg
Volume Treated	10000 ft3
Air Changes per Hour	8
Room Volume (Assuming 28.3 liters/ft3 and 1000 liters/m3)	283 m3
Ventilation Rate	37.7 m3/hr

Rate of Increase Formula

$$C = (GA/Q) * (1 - e^{-Qt/V})$$

Where:

ADBAC air concentration (C)	mg/m3
Generation Rate (GA)	680.5 mg/min
Ventilation Rate (Q)	37.7 M3/min
Room Volume (V)	283 M3
Elapsed Time (T)	Minutes

Rate of Decrease Formula

$$C = C@ \text{Time Zero} * 0.5^{(T/0.693 * Q/V)}$$

Re-entry Interval (REI) = 25 Minutes

Increase During Application

Time	GA/Q	QT/V	$e^{-QT/V}$	C (mg/m3)
0	18.034	0.00	1.000	0
1	18.034	0.13	0.875	2.25
2	18.034	0.27	0.766	4.22
3	18.034	0.40	0.670	5.94
4	18.034	0.53	0.587	7.45
5	18.034	0.67	0.513	8.77

Decline following Application

Time (Min)	C (mg/m3)	8 Hr TWA with REI (mg/m3)
0	8.8	
1	7.7	
2	6.7	
3	5.9	
4	5.1	
5	4.5	
6	3.9	
7	3.4	
8	3.0	
9	2.6	
10	2.3	
11	2.0	
12	1.8	
13	1.5	
14	1.4	
15	1.2	
16	1.0	
17	0.91	
18	0.80	
19	0.70	
20	0.61	
21	0.53	
22	0.47	
23	0.41	
24	0.36	
25	0.31	0.0046

